UNVEILING RISK PATTERNS THROUGH AN IN-DEPTH ANALYSIS OF SLOVAK COMPANY DEFAULTS (2014−2018)

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Abstract. This article comprehensively analyses Slovak company defaults between 2014 and 2018, seeking to identify non-financial risk patterns across different sectors, regions, company ages, and legal structures. The study encompasses 168,252 Slovak companies, of which 941 experienced defaults. This paper employs descriptive analysis to outline and summarize pivotal characteristics of the data, thereby understanding the overarching trends in company defaults. This method enables for a more informed approach to develop risk mitigation strategies. The main objective of this article is to unveil the non-financial risk patterns among defaulted companies. The scope of this analysis includes companies operating within Slovakia, offering a comprehensive view of the default dynamics within this geographical and economic context. Our findings point to a gradual decrease in company defaults over the study period. Bratislava region stood out as having the highest number of defaulted companies; however, when looking at the proportion of bankruptcies, Kosice region exhibited the highest percentage of business failures. An interesting age-related pattern emerged from our data, showing a significant concentration of defaults among companies aged between 3 to 9 years. Yet, when defaults are examined as proportions within each age group, companies aged 18 to 22 years demonstrated the highest bankruptcy rates. Industry-wise, the construction sector recorded the highest number of defaults, aligning with the general vulnerability of joint stock companies, which showed a higher likelihood of defaulting at older ages. On the contrary, limited liability companies tended to default more frequently at younger stages of their lifecycle. Notably, the information technology sector emerged as the industry with the lowest default rates, highlighting its relative financial stability compared to other sectors.

Keywords: bankruptcy, default, risk factors, company, sectoral analysis.

JEL Classification: G33.

1. Introduction

In the dynamic business and finance environment, it is crucial to understand potential risks for the company's resilience. Especially to unveil risk patterns that have significant implications for policymakers, industry practitioners, investors, and the business community. In general, facing bankruptcy comes along with very challenging circumstances because it results in significant adjustments and, most of the time, the complete termination of its operations. Additionally, the main motivation for privately held companies is to generate profit, which is extinguished upon the bankruptcy declaration. Consequently, businesses prioritize avoiding bankruptcy, driven by the will to generate income for owners, creditors, and other stakeholders such as employees.

Nevertheless, the company's position could be reversed by instability in the political, economic, and sectoral environments in which it operates. The dynamics of bankruptcy extend beyond financial indicators and metrics, encompassing a complex combination of internal and external factors that influence a company's resilience. This may result from lower-than-expected earnings, increased and unforeseen expenses, shifting in important macroeconomic principles, or changes to the company's legal structure. Moreover, the loss of some significant clients not only affects revenue streams but also undermines the stability of business operations. Bankruptcy then serves also as a critical indicator of the broader economic health of a region. As companies navigate the complexities of the Slovak business landscape, a comprehensive

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exploration of default patterns becomes essential for informed decision-making, risk management, and the formulation of strategic initiatives. The chosen time frame, from 2013 to 2018, provides a window into the analysis of risk patterns during a period without attaching to the business market affected by the COVID-19 pandemic or the Russian invasion of Ukraine, focusing on industry dynamics, making it a ground for un-covering distinctive risk patterns.

Given the context of this time range and focusing on non-financial variables, regional disparities, and the sensitivity of various legal forms to default. The findings intend to offer stakeholders a comprehensive understanding of the risk landscape in the Slovak business environment. This research seeks to provide insights that can inform strategic decisions, guide policy formulation, and enhance risk management practices for businesses operating in Slovakia.

2. Literature review

The popularity of bankruptcy prediction models dates from the mid-60s 20th century when the research focused on a univariate analysis involving only one financial variable (Beaver, 1966). The more extensive approach that is broadly used also nowadays has been introduced by Altman (1968). His original model, based on the inclusion of five financial variables, was revised to better analyze the financial health of the companies that are not traded on the stock exchange, e.g., to be able to predict the financial distress of the private companies as well as to exclude the sensitivity of the industry patterns and differences by excluding ratio of sales on total assets (Altman, 1983). The performance of the revised model was examined in the first comprehensive international analysis of 31 European and three non-European countries by Altman et al. (2017). The literature on company defaults offers many analyses of potential risks. Usually, it can be observed through changes in financial ratios. However, not only financial ratios do extensively influence company performance.

Keasey & Watson (1987) published one of the first studies including non-financial variables in failure models for small and medium-sized firms. Many other studies followed confirming that non-financial firm-specific predictors contribute to increasing the default prediction power. The most recent academic research has often focused on seeking the patterns of both financial and non-financial determinants suggesting a company's risk of default. Smith & Alvarez (2021) analysed firm-level bankruptcy on financial accounts of 58,000 non-bankrupt firms along with 6057 bankrupts. They revealed that within industries, the construction sector exhibits the highest percentage of bankruptcy rates despite being the third most significant sector in terms of the number of firms. During their study period, Madrid, Catalonia, Valencia, and Andalusia, the four most populous regions, all recorded a significant number of bankruptcies. The key financial performance indicators and a company's

industry according to Standard Industrial Classification were taken into consideration by Lohmann & Möllenhoff (2023) for the purpose of analysing pre-bankruptcy investor attention and behaviour. To attain this, they formed two groups of US-listed companies that share similar structures. The first set consisted of companies that faced bankruptcy between 2005 and 2016, while the second set comprised companies facing financial distress but maintaining solvency.

Arora & Saurabh's (2022) study's objectives were to specify the financial ratios that can anticipate a company's distress. In pursuit of this aim, they gathered information on 262 financially healthy firms within the identical industry and size-decile as the struggling companies. The size classification was determined by averaging the income and assets over three years.

In their review of the literature on the prediction of business failures, Dimitras et al. (1996) revealed the majority of studies categorize industries based on three types of firms in their samples: manufacturing firms, a combination of manufacturing and retailing firms, or firms from various industrial sectors. Notably, in this earlier comprehensive survey only two studies concentrated on a specific industrial sector – the textile industry.

Including textual website data was shown to improve business default predictive performance of the Borchert et al. (2023) study. Their research concluded that extending the utilized framework to a diverse range of companies and industries holds significant promise for extracting risk insights with broader applicability.

When task-specific features like financial ratios, industry-specific metrics, market indicators, legal and governance factors, or qualitative data are incorporated into the predictive model, according to El Madou et al. (2024), it can provide insightful information and support decision-making regarding bankruptcy risk.

The significance of accounting for industrial effects in hazard rate estimation can be seen by Chava & Jarrow (2004). It suggests that industry groups have a major impact on the forecasting of bankruptcy risk and affect both the intercept and slope of included coefficients. Likewise, Staňková (2022) chose variables for analysing the logit bankruptcy prediction model threshold based on the selected industry and a specific period. Using survey data from Spanish manufacturing enterprises, the study by Esteve-Pérez et al. (2010) indicates a pattern between the determinants of companies' exit paths and nonfinancial and industrial factors. Companies were classified by industrial sectors and size categories, including 2,998 firms with more than ten employees, corresponding to 17,969 observations. The findings from Thornhill & Amit (2003) affirm that the industry a firm belongs to has an impact on its survival.

The legal form chosen by the firms serves as an indicator of the riskiness of the firm's undertaking projects and has an impact on its growth and exit. Harhoff et al. (1998) used a sample of almost 11,000 West German companies in the manufacturing, construction, trade,

and service industries to show that companies under limited liability have greater insolvency rates than equivalent companies under total liability in all sectors.

According to Mata & Portugal (2002), the legal structure of a company highly affects its decisions. They proved a statistically significant difference in the likelihood of remaining on the market between limited liability and unlimited liability enterprises. Iwasaki & Kim (2020) investigated the relationship between legal forms of incorporation and business existence across industries by tracking the survival status of over 110,000 Russian enterprises over eight years. Using the Cox proportional hazards model, they discovered that closed joint-stock form and limited liability, as opposed to open joint-stock companies, partnerships, or cooperatives, maximize the likelihood of the firm surviving. Fidrmuc & Hainz (2010) identified a tendency of conflicting motivational decisions from shareholders and company management that encourages the management to take more risks. Conversely, the risk of bankruptcy is reduced for family firms or limited liability organisations whose management collaborates closely.

To predict the default of SMEs, Gallucci et al. (2022) combined three distinct types of variables: financial ratios, corporate governance data, and bank-firm information. They comprised the following control factors in total: bank capitalization, legal form, age, location, industry, and business size. Three dummy variables about the enterprises' geographic locations were used to operationalize location, allowing for the capture of various industrial and economic characteristics that define the Italian business system, in the case of joint-stock corporations.

A company's age impact on default is well documented in the literature, although the relationship is not straightforward. The likelihood of the company defaulting is reduced because it has been in business for a longer time and has accumulated more assets, experience, and bigger profits. If older businesses fail to adapt to meet the demands of a developing business market, they will become more risk-vulnerable (Thornhill & Amit, 2003). On the other hand, a newly established business often requires a large amount of start-up capital to fund its operations; nevertheless, profits are not a requirement. Consequently, the likelihood of the company going bankrupt is reduced during the initial years and increases subsequently when start-up funding is no longer provided. Businesses that have made it through these stages will grow more resilient, and the failure rate is expected to decrease (Thornhill & Amit, 2003; Káčer et al., 2019). There was also a proven linkage between the age of the company during default and the industry it belongs to. In the food, beverage, and accommodation industry, early failures were more likely to occur especially in businesses like bars and restaurants that were known for their short lifespans mainly due to strategy or performance dynamics from those in the high-tech or industrial industries. Conversely, businesses in the retail and wholesale industries typically had a higher average age when they went bankrupt (Thornhill & Amit, 2003).

3. Data and methodology

The study references to a robust data source that includes details from 168,252 businesses operating in Slovakia during 2013 and 2018. The study focuses on joint stock corporations and limited liability companies, investigating the risk patterns within these particular business forms. 941 defaulted companies were identified over the research period through the dataset. Defaulted companies are defined as those unable to meet their financial obligations. This variable is an essential component of the study for investigating the various aspects that affect financial distress.

The research tries to identify potential localised factors contributing to enterprises' financial distress by considering different areas. According to OECD (2022) Slovak Republic exhibited one of the highest levels of regional economic inequalities among OECD countries. Similarly, Messner & Zavadil (2014) analysing general regional data pointed out large disparities between the west and east of Slovakia. The presented study focused on Slovakia's eight regions allowing a detailed analysis of regional economic differences.

The analysis includes categorizing into 33 sectors, each representing a different aspect of the country's economy. This sectoral segmentation helps conduct a thorough analysis of the risky industries. Moreover, including a variety of industries improves the study's capacity to spot trends, patterns, and industry-specific dynamics.

The analysis incorporates a time component as the average age is computed according to the year of establishment of every company. On average, the companies in the dataset have been operating for about 8.2 years. It is essential to understand the lifecycle of an organisation and the possible relationship between an organization's age and the probability of facing financial difficulties.

A ground for more complex inferential studies is laid by descriptive analysis, which entails highlighting and summarising the data's key features. Understanding the overall trend of default rates, the average age of the company, regional and industrial throughout the given period is especially dependent on descriptive analysis. Finding the patterns lays the groundwork for deeper analyses and the development of further hypotheses. Using descriptive statistics, we have compared default rates, firm age, and other pertinent metrics between various regions and sectors. This contributes to a more detailed knowledge of the various nonfinancial factors driving economic distress by enabling the identification of sectoral and regional differences. It helps identify significant trends, variances, and patterns that lead to a more thorough knowledge of the variables driving default risk. It also serves as a strong framework for inferential analysis.

4. Results

Across the analysed period the highest number of defaults occurred in 2013, with 232 companies facing financial
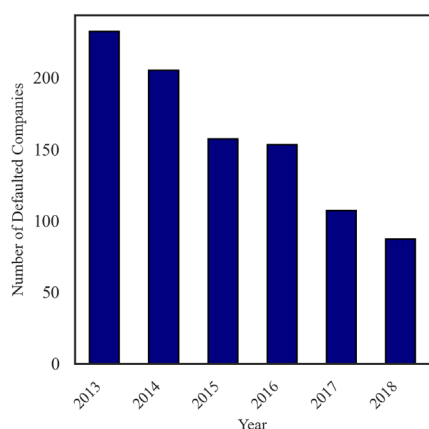
Figure 1. Number of Defaulted Companies Across the Analysed Period (*source*: authors' own work based on data from FinStat Premium Database)

distress. Subsequently, there was a gradual decline in defaults over the following years, reaching the lowest point in 2018, when only 87 companies experienced financial difficulties. This temporal trend suggests an improvement in the financial stability of companies after the European debt crisis that contributed to the financial instability over this period. The decline is also linked to improving the overall Slovak economic situation.

Different patterns of financial distress are revealed by analysing the number of enterprises that have defaulted in different regions. With 272, Bratislava is the region with the biggest number of defaulted business entities. Kosice with 131 defaults, follows after, suggesting a substantial concentration of struggling companies in the east of the country. There are also significant numbers of defaults in other regions, namely Banska Bystrica and Presov (99 and 107). Relatively lower numbers are seen in Trencin, Nitra, Trnava, and Zilina, indicating a slightly better financial environment in these areas. Due to quite big regional disparities among the Slovak regions, Figure 2 analyses default rates across the regions based on the ratio that represents the percentage of companies with defaults relative to the total count in each region.
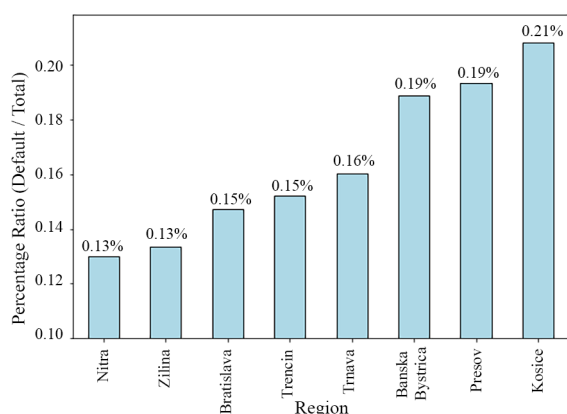

Figure 2. Ratio of Defaulted Companies for each Region (*source*: authors' work based on data from FinStat Premium Database)

Analysing the risk patterns across the region, Kosice is notable for having the largest proportion of defaulted businesses – roughly 0.21% of all the enterprises in this region. Closely behind are Presov and Banska Bystrice, accounting for 0.19%, respectively. Although Bratislava was identified as the area with the greatest number of businesses defaulted when accounting for the total number of businesses in the region default rates are considered to be among the smallest. It is the most developed region, accounting for 31% of companies within the country. This is 22.5% more than Banska Bystrica, which had the second-highest position in terms of the number of businesses during the time upon analysis.

Based on the available data, we revealed that a significant number of company defaults occur in the age range of 3 to 9 years old. Specifically, 64, 63, and 63 defaults happened at ages 5, 7, and 8, respectively. However, we need to notice that number of active companies older than 10 years gradually decreases. As the company gets older, the number of defaults gradually decreases, too. There are only 40 defaults filled for default after ten years. For example, only 13 defaults were noted for organizations older than 23 years old, and the bankruptcy numbers further declined after that. In Table 1, the number of defaults is presented according to the category in that span of 5 years range, pointing to the fact that after companies reached 20 years of operations (20–25), the number of occurred defaults decreased by 44%.

Table 1. Defaulted Companies by Age Category

Age Category	Number of Defaults
0–5	287
5–10	273
10–15	159
15–20	140
20–25	78
25–30	4

Source: authors' work based on data from FinStat Premium Database

However, more in-depth information was discovered when we compared the number of defaults with the default ratio within the age range. According to Figure 3, while the number of defaulted companies is generally lower for older age, the default ratio tends to be higher in those age groups, suggesting that risk factors may change as businesses age. Notably, the highest default ratio is observed among 19-year-old companies, reaching 0.35%. This suggests that a company's likelihood of default increases with operating duration, which may be caused by insufficient investment in research and development to keep up with market development.

The number of defaults in each industry presented in Table 2 shows how the risk pattern of Slovak company's defaults differs between industries. Interestingly, businesses with higher default occurrences include Construction, Wholesale, Retail, Travel and Hospitality,
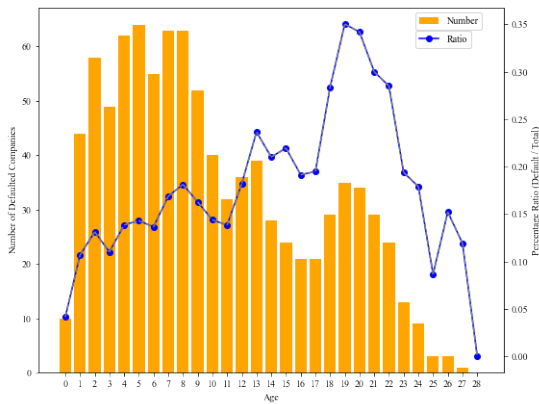
Figure 3. Comparison of Number of Defaulted Companies and its Ratio by Age (*source*: authors' work based on data from FinStat Premium Database)

Table 2. Defaulted Companies by Industry

Sector	Defaults	Share
Telecommunications	1	0.05%
Automotive Industry	3	0.05%
Education	3	0.39%
Manufacturing – Other	4	0.05%
Development and Testing	4	0.18%
Advertising	5	0.04%
Information Technology	9	0.03%
Waste Processing	12	0.28%
Electrical Engineering	12	0.47%
Media, Publishing and Culture	13	0.14%
Chemistry and Plastics	14	0.37%
Finance	16	0.04%
Vehicle Sales and Maintenance	16	0.13%
Healthcare	16	0.15%
Energy and Mining	18	0.09%
Projecting and Engineering	18	0.47%
Mechanical Engineering	19	0.26%
Clothing and Footwear	20	0.59%
Services	22	0.07%
Wood and Paper	23	0.32%
Food Industry	25	0.43%
Law, Consulting and Accounting	26	0.05%
Intermediation	30	0.15%
Agriculture and Forestry	32	0.26%
Real Estate	42	0.13%
Transportation and Logistics	46	0.16%
Metallurgy	46	0.32%
Travel and Hospitality	66	0.19%
Retail	77	0.14%
Wholesale	121	0.23%
Construction	182	0.27%

Source: Authors' work based on data from FinStat Premium Database

Metallurgy, Transportation and Logistics. This suggests higher financial risks within these sectors. Conversely, industries with lower default numbers include the Telecommunications, Automotive, and Education sectors; facing lower danger of bankruptcy. When we analysed the share of defaulted companies closely to total companies within the industry sectors like Waste Processing, Energy and Mining, and Clothing and Footwear have higher default shares, suggesting a comparatively higher risk of defaults. At the same time, Information technology exhibits the lowest rate. Public administration and companies providing Gambling have not defaulted during the period upon analysis and, therefore, are not included in the Table.

To closely analyse six risky sectors, of which 430 (46%) companies faced default. we have visually displayed the age distribution of defaulted companies across various sectors in Figure 4. The Construction sector, which has the highest concentration of defaulted enterprises, has an average age of roughly 10.97 years. The Waste Processing sector also exhibits a higher mean age, indicating potential instability. Another noteworthy point is that all three sectors with the most defaults faced defaults within one year after setting up a business. The Clothing and Footwear sector exhibits the highest variability with a broader age range according to its interquartile range. The diverse default age distribution is observed in the Wholesale industry, with a maximum age of 27 years.

When sorted by legal form. Slovak corporations' default risk pattern provides some interesting insights. Joint Stock Companies have a lower default rate (95 instances), mostly due to an imbalance in the dataset (15 129 compared to 572 864). Nevertheless, out of all joint stock firms. 0.63% have defaulted; this is four times higher than Limited Liability Corporations, which, although having 846 defaults, have just a 0.15% default rate.

Figure 5 displays the patterns in the distribution of defaulted companies across different legal forms where particularly defaulted companies tend to be concentrated in specific age ranges. The density of the plot suggests a very significant finding, namely that the joint stock legal form group has a larger density of defaulted corporations
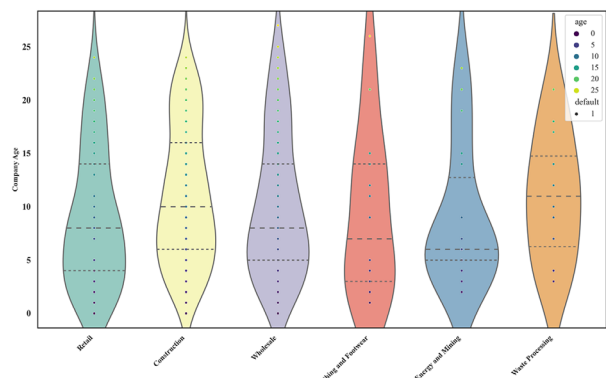

Figure 4. Distribution of Defaulted Companies across Sectors by Company Age (*source*: authors' work based on data from FinStat Premium Database)
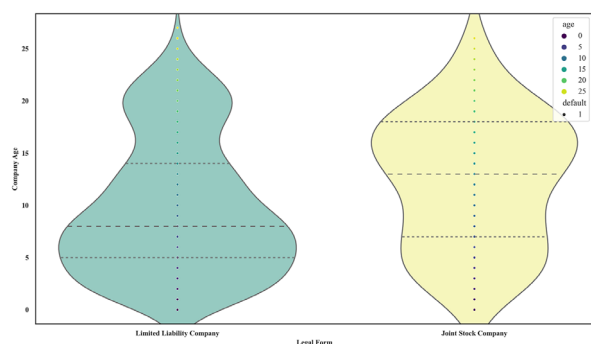
Figure 5. Distribution of Defaulted Companies across Legal Forms by Company Age (*source*: authors' work based on data from FinStat Premium Database)
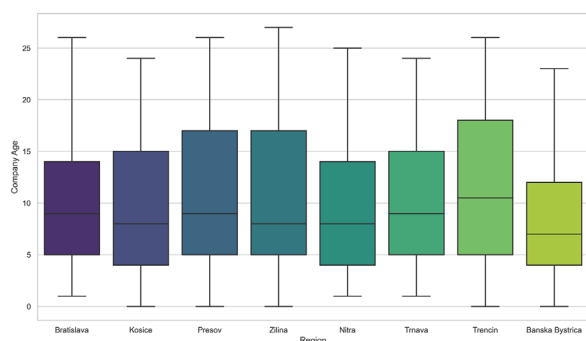

Figure 6. Distribution of Defaulted Companies across Regions by Company Age (*source*: authors' work based on data from FinStat Premium Database)

at oldercompanies' ages. This is different when we look at the limited liability companies where there is a higher density in the lower age.

The average age of the defaulted companies is 10.14. The Distribution of Defaulted Companies by Company Age by Region is displayed in Figure 6.

It indicates that in a region of Banska Bystrica which has the third highest default rate, young companies have been particularly at risk. This region has the lowest interquartile range of the age of defaulted companies. It has also the lowest median value and half of the defaulted companies in this region have an age below 7. In Trencin, the highest Interquartile range spanning from approximately 5 to 18 is observed. It points out that the middle 50% of defaulted companies in Trencin have age within this particular range. However, the distribution of the first quartile of the age of defaulted companies does not differ much across the regions. The whiskers indicate that the Zilina region has defaulted companies at the highest age.

5. Discussion

We have provided an overview of the importance of understanding bankruptcy risks in the dynamic business environment focusing on non-financial company-specific variables of the Slovak companies. Using the time frame from 2013 to 2018 excludes the impact of external

events such as the COVID-19 pandemic or the Russian invasion of Ukraine. The presented analysis shows a gradual decline in defaults over the years with the highest number of defaults occurring in 2013 (232 companies) and a subsequent gradual decline, reaching a low point in 2018 (87 companies). This temporal trend suggests an improvement in the financial stability of companies after the European debt crisis. Bratislava emerged as the region with the highest number of defaulted business entities. 272. Since big regional disparities have been confirmed by the number of businesses operating which also aligns with previous research (Messner & Zavadil, 2014; OECD, 2022). Bratislava, despite having the highest number of defaults, had relatively lower default rates, considering its large number of businesses operating the in region. When analysing default rates relative to the total number of businesses in each region. Kosice had the highest percentage of defaulted businesses (approximately 0.21%), followed by Presov and Banska Bystrica (0.19% each). A significant number of defaults in the sample occurred in the age range 3 to 9 years. However, if we analyse defaults by proportions in each age group, the highest rate of bankruptcies is observed in the age range 18 to 22 years. This can be attributed to inadequate investment in research and development to adapt to market changes (Thornhill & Amit, 2003). Companies older than 22 years exhibit a gradual decrease in defaults, highlighting the potential resilience gained with accumulated assets and experience which aligns with Thornhill & Amit (2003) and Káčer et al. (2019). Possible reasons were revealed in the survey by Kücher et al. (2018) claiming internal issues account for most of the failures of young and adolescent businesses, growing small and medium-sized businesses face more challenges from increased competition and economic downturns. Analysis of defaults across industries revealed the highest default numbers in construction sectors, indicating higher financial risks as corresponding to the study by Smith & Alvarez (2021) referring to the construction sector as risky. Suggesting that risk models created to be universally applied across industries may not be the best fit for the construction sector, as its distinct financial risks that require specialised modelling techniques (Kanapickienė et. al. 2023). Conversely, industries with lower default numbers included telecommunications as within the Spanish business market (Smith & Alvarezt. 2021) suggesting the lowest risk of bankruptcy in this area of the market. A closer examination of the share of defaulted companies among total companies within specific industry sectors highlighted higher default shares in Waste Processing. Energy and Mining, and Clothing and Footwear, emphasizing comparatively higher risks in these sectors. However, information technology was shown to have the lowest default rates, supporting Madulova's (2018) findings that the industry is a key contributor to Slovak economic growth and development that could diminish regional disparities. Despite the lower number of defaults in Joint Stock Companies, the percentage of defaulted

companies (0.63%) was four times higher than that of Limited Liability Corporations (0.15%) which aligns with the conclusion of Fidrmuc & Hainz (2010).

Analysis of the distribution of defaulted companies across legal forms revealed distinct patterns, with Joint Stock Companies showing a higher density of defaulted corporations at older ages, while Limited Liability Companies exhibited a higher density at younger ages. The distribution of defaulted companies by age and region indicated only minor variations across different regions. In the region of Banska Bystrica, characterized by the third-highest default rate, there is a notable vulnerability among young companies, highlighted by the lowest interquartile range and a median age of 7 for defaulted companies.

6. Conclusions

The main finding of the analysis is the consistent decline in company defaults since 2013, along with variations across regions, legal forms and age of the companies. Bratislava had the highest number of defaults, while Kosice had the highest percentage relative to number of businesses operating in region. Most defaults were recorded in companies aged 3 to 9 years, but the highest bankruptcy rates were seen in those aged 18 to 22 years. The construction sector had the highest number of defaults, in contrast to the information technology sector, which had the lowest default rates. Furthermore, the data indicates that Joint Stock Companies were more likely to default at older ages, while Limited Liability Companies were more vulnerable at younger stages. These findings offer insightful information to stakeholders, enabling a better-informed approach to risk management strategies tailored to certain industries, geographical areas, and legal structures within the Slovak business environment. The findings also suggest potential areas for further research in bankruptcy prediction modelling.

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The authors declare that there is no conflict of interest.

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